

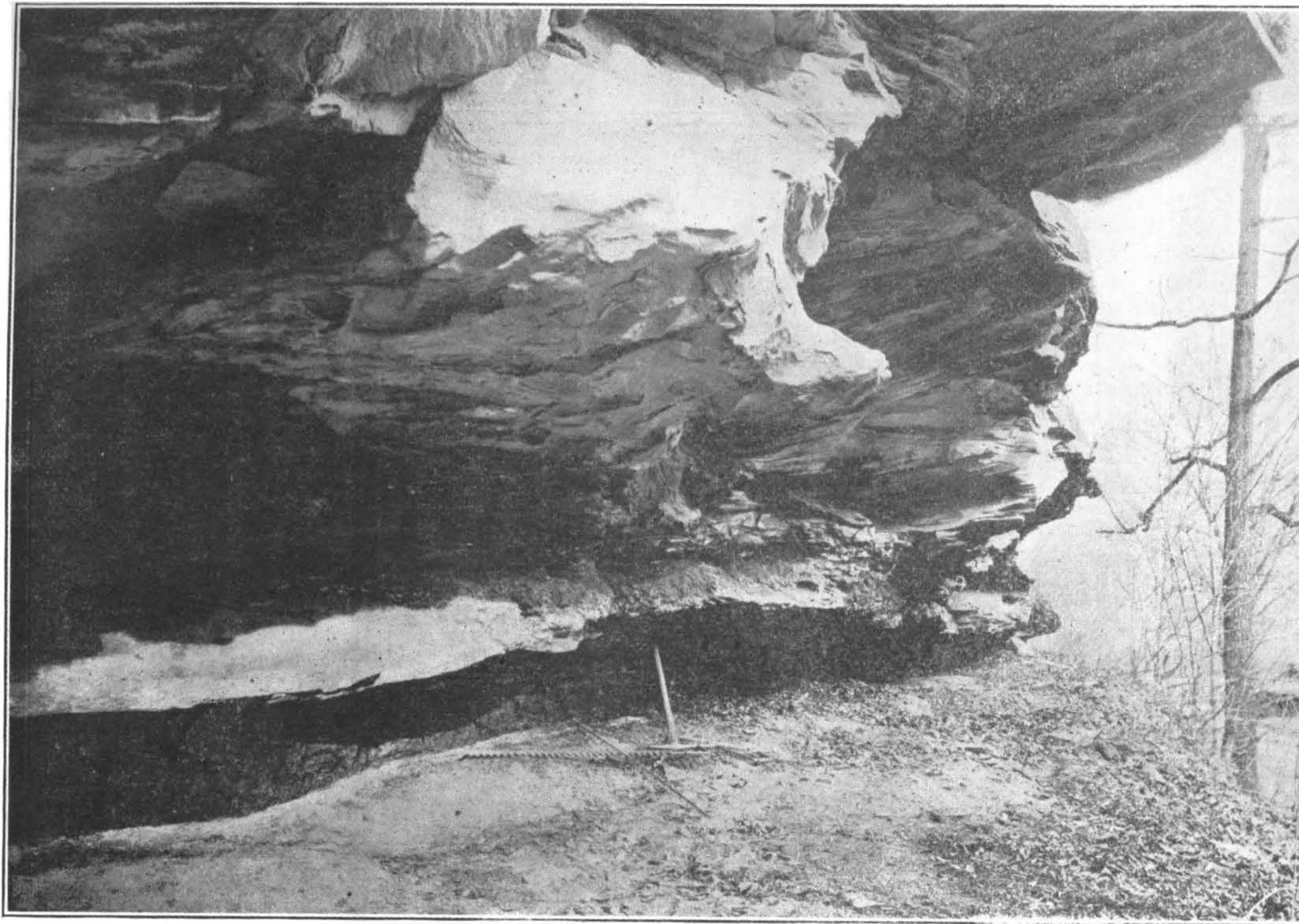
The
Kentucky Geological
Survey

WILLARD ROUSE JILLSON
DIRECTOR AND STATE GEOLOGIST



SERIES SIX
VOLUME SIX

The Sixth
Geological Survey
1921



THE WHITESBURG COAL AND SANDSTONE "ROCKHOUSE" ROOF.

This characteristic view of the well known Whitesburg coal and its superimposed thirty feet of cliff forming sandstone may be seen on Otter Creek just above its juncture with the Middle Fork of the Kentucky River in Perry County.

THE SIXTH GEOLOGICAL SURVEY

An Administrative Report of the Several Mineral Resource
and General Geological Investigations Under-
taken and Completed in Kentucky
during the Biennial Period
1920-1921



By
WILLARD ROUSE JILLSON
DIRECTOR AND STATE GEOLOGIST

PRESENTED WITH TEN SEPARATE
MISCELLANEOUS GEOLOGICAL PAPERS

BY
GEORGE P. MERRILL,
STUART WELCHER
WILLARD ROUSE JILLSON
STUART ST. CLAIR
AND
CHARLES STEVENS CROUSE

*Illustrated with 101 Photographs
Maps and Diagrams*

First Edition

1,000 Copies

THE KENTUCKY GEOLOGICAL SURVEY
FRANKFORT, KY.
1921



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PREFACE

Applied geology is of great economic value to every State in which natural resources are only partly developed. This is especially true of Kentucky where the great body of mineral resources are now less than 20% under commercial operation. An ideal arrangement would be one where the State would have completed the base (topographic) mapping and the preliminary geological-resource surveys prior to the opening up of any oil, coal, natural gas, asphalt or other field. During the period of proving up such a field, State employed geologists could well work hand in hand with the operators, and assist them greatly in their efforts to win the resources desired.

Unfortunately this ideal arrangement has never existed in Kentucky, though it has to some extent in other States. With only 46% of Kentucky base (topographic) mapped, and with an area approximating that of sixty counties not covered by any accurate maps at all, the function of the Kentucky Geological Survey has always been crippled and held in restraint. The day of a 100% efficiency of the Kentucky Geological Survey seems yet to be in the distant future.

During the last biennium a large number of subjects of great economic value to this State have been investigated, however, by the Kentucky Geological Survey. A full account of these investigations is presented herewith in the first paper of this volume entitled, "The Sixth Geological Survey." A number of these economic papers are included within the covers of this book, and should assist materially in an understanding of the geology and resources of the several regions covered. This report is issued in an original edition of one thousand copies.



Director and State Geologist.

Old Capitol,
Frankfort, Kentucky.
December 15, 1921.

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THE SIXTH
GEOLOGICAL SURVEY

IX

DRAINAGE PROBLEMS IN KENTUCKY.

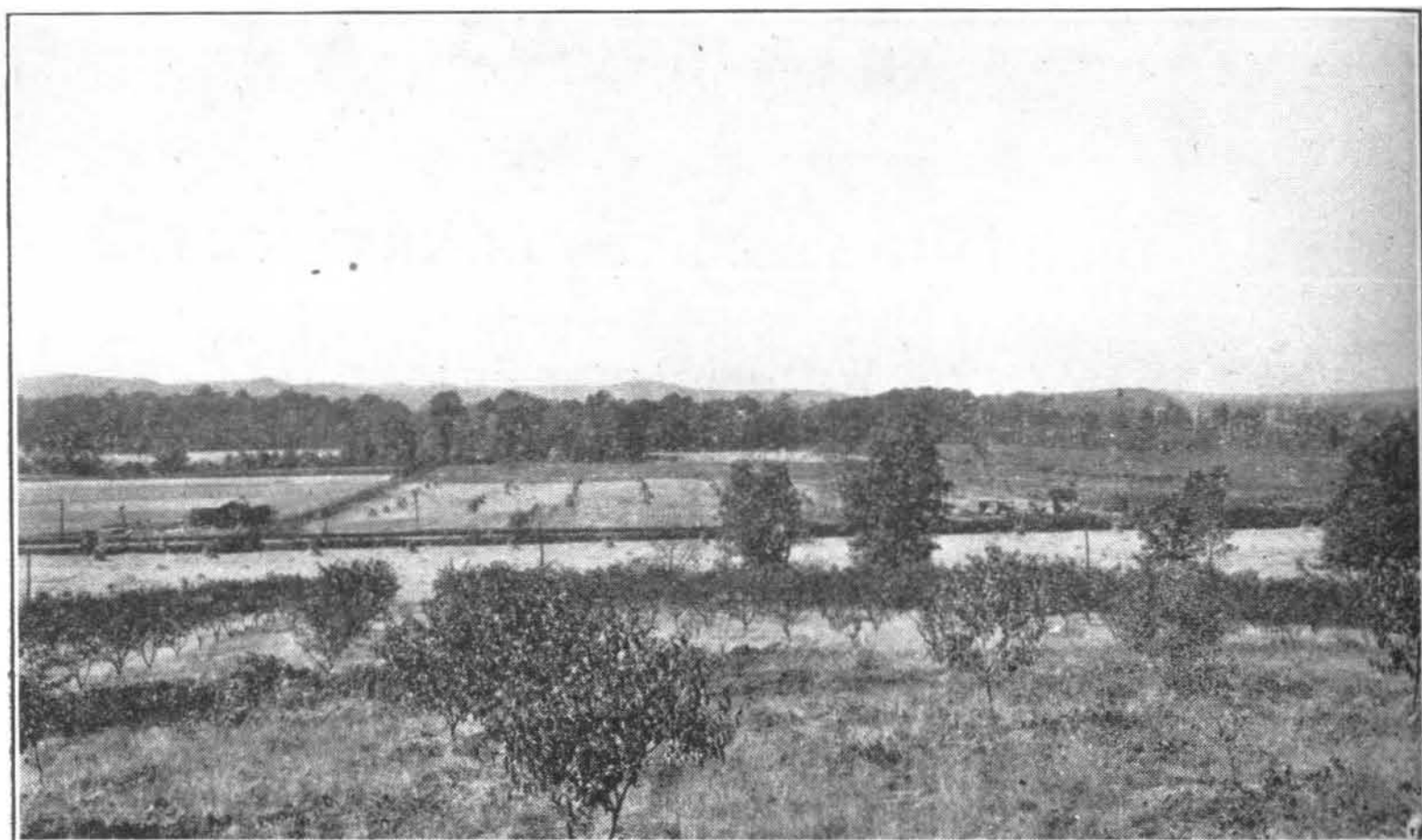
BY WILLARD ROUSE JILLSON.
Director and State Geologist.

INTRODUCTION.

Due to its geographic position and topography, Kentucky, like many other states of the Mississippi Valley, finds its general health and agricultural interests closely identified with the proper solution of a group of well defined drainage problems. While for the greater portion of Kentucky natural drainage effected by the normal erosion of the streams is ample and sufficient, certain restricted areas, due to their peculiar topography, must necessarily employ artificial drainage to carry off excessive overflow waters, or reclaim swamp lands. Drainage is herein defined as an artificial scheme of ditching designed to remove excessive water from relatively large areas, either through systems of open channels or by covered conduit or tile, for the purpose of improving agricultural land, or advancing the general sanitary and health conditions.

NEED OF DRAINAGE.

Although the question of drainage is more forcefully realized by the people of western Kentucky in the Ohio bottoms, the Western Coal Field and the Purchase region, because of the large areas of lowlands in these sections, it is a question of real importance to the people of the entire State, since it means not only the reclamation of swamp lands and the control of floods on overflow lands, but also the improvement of the general health and the increase of the total capitalization of the State. There are approximately 570,000 acres of swamp and overflow land in western Kentucky alone, practically all of which is susceptible to reclamation and increased productivity if properly



DRAINED AND UNDRAINED LANDS.

These flat lands are located just North of South Park Station on Wilson's Creek, Jefferson County, Ky. The lands under cultivation on the left have ditches and tile drainage. The brush-covered area on the right capable of the same results is undrained.

drained. In many instances no engineering difficulty stands in the way of draining any particular region. When we consider that these swamp and overflow lands, now partially improved it is true, but for the most part abandoned and unproductive, cover an area of about the same size as Luxemburg (Europe), which had a population of 259,899 in 1910,¹ it will be seen that this State has a real opportunity in developing these areas and allowing for normal and prosperous increase of its population.

While it is not to be inferred that the same amount of people could be crowded onto improved lands in Kentucky as may occupy through force of necessity the same area in good agricultural lands in older portions of the world, it is nevertheless a fact that these areas which now serve little or no agricultural purpose and act at the same time as a great deterrent to the public health, could be made attractive to the intelligent farmer as healthful homestead sites. Practically all of these areas are crossed by the great railroad systems of Kentucky, which would allow a larger and more intensified cultivation of these lands

¹New International Encyclopedia, Vol. XVI, p. 497.



A FORMER SWAMP CULTIVATED.

This portion of the J. H. Caperton ranch now drained by the South ditch was formerly under water for long periods. It now supports pasture, hay and grain fields.

than might in other cases be anticipated. In actual elevation many of the overflow and boggy lands of Kentucky are naturally sufficiently elevated above the neighboring water courses to make drainage feasible, but this is usually beyond the reach of the individual, and must be taken up through county or state organizations, employing whenever feasible, Federal aid.

Sanitary drainage is a matter which affects in some way or other, either directly or indirectly, the health and physical well being of every citizen. There are few communities where the conditions of the general health could not be improved by careful attention to proper drainage of the vicinity. This should include not only the proper disposal of municipal sewage, but the removal of all standing water in close proximity to the town or village. Sanitary drainage is feasible in many ways, but probably is most marked in its effective prevention or the



THE NORTH DITCH.

The view is Eastward from the Third Street Bridge. The filling up of the channel with willows and other small vegetation is evident.

diminution of diseases of the malarial type. The removal of standing water eliminates at the same time the greatest obstacle to good farming in many regions, and with it the breeding places of mosquitoes, which insects are now well recognized as the only carriers of the malarial germ. Where there are no swamps or boggy localities, the mosquito nuisance is not felt, and

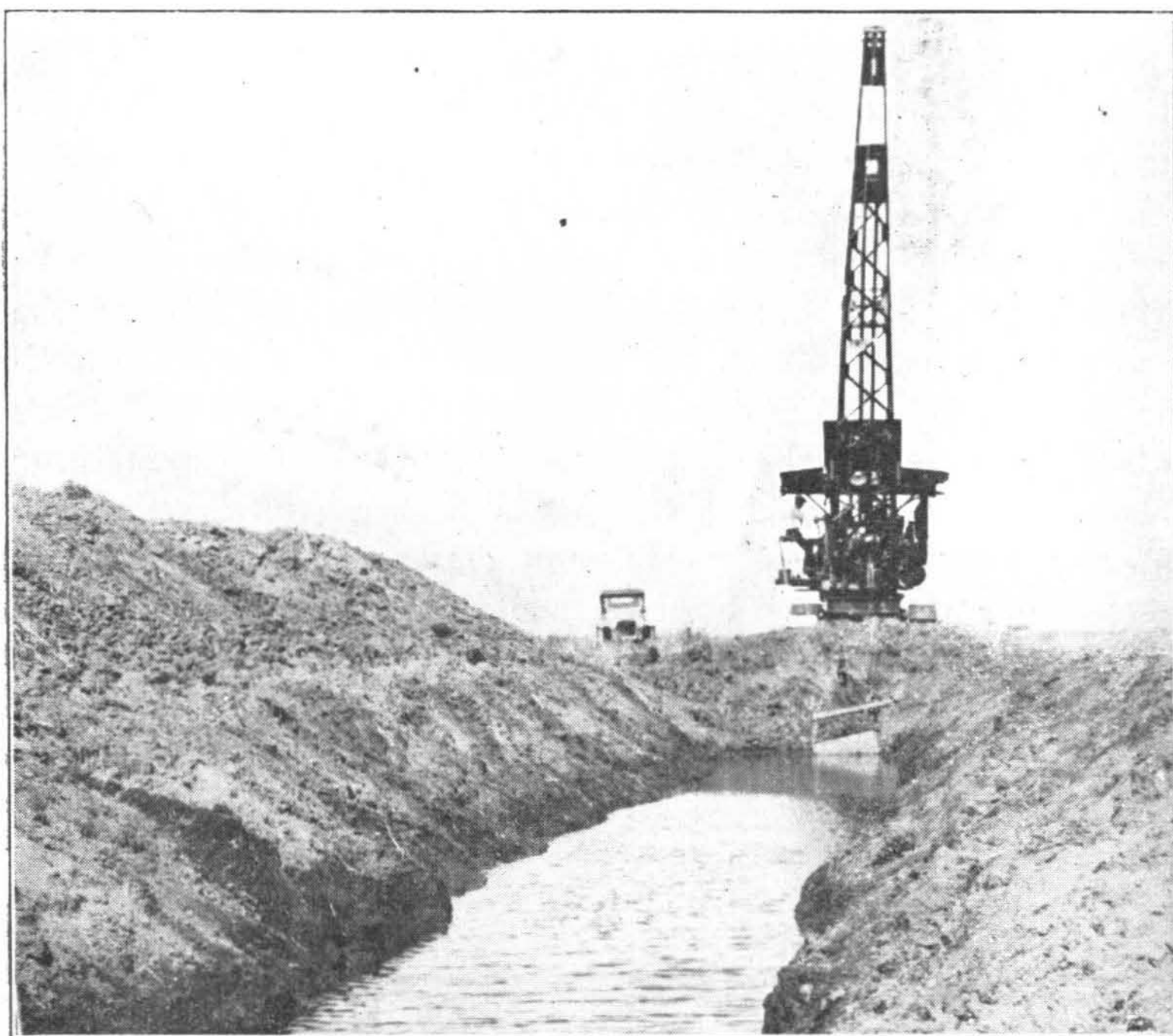
as a consequence malarial influences are obviated. It is a fact that in many parts of eastern Kentucky where the system of natural dendritic drainage is almost perfect, the mosquito is rare and malaria practically unknown.

HISTORICAL.

The subject of agricultural drainage is probably quite as old as the art of farming. Rich overflow lands as well as swamp lands have long claimed the attention of agricultural peoples, and this is particularly true of the valleys of the Nile and Jordan, where even in times of great antiquity large areas were watered artificially and drained artificially in order to allow the use of these rich though naturally unproductive areas. Artificial drainage was practiced by the Greeks at a very early time when the marshy swamp lands about the Lake of Copias near Thebes, embracing about sixty thousand acres, were reclaimed.¹ On the North American continent the Aztec kings, probably about the 14th century, built their city on the island in the lake in the Valley of Mexico, and protected it by dykes of great magnitude. In Europe, Holland has been engaged in the construction of vast drainage works for many centuries, and large areas have been reclaimed from the sea through the construction of great dykes. In this instance gravity drainage is impossible over large areas. The water in these drainage canals is discharged by pumping, the power required being generated through the use of many large wind mills. These wonderful Dutch projects, known throughout the world, have added thousands and thousands of acres of rich and productive agricultural lands to Holland.

Much work has been done within the last few decades in the United States by individuals, corporations, counties and states. Chief among the important projects are those of New Orleans, La.; Florida, Minnesota, North Dakota, and in the lowlands of Indiana and California, and other States. In Kentucky, drainage enterprises have been under way for over thirty years, the first project having been started about 1890. The growth of drainage projects in this State is well illustrated by the following table, which shows an increase from slightly more than fif-

(1) Proceedings of Drainage Convention North Carolina Geological and Economic Paper No. 17, p. 45.



DITCH DIGGING IN A SWAMP.

This excavator-crane is operating under the normal conditions of high water table in soft swamp lands. These machines are used by the Dept. of Dykes, Vancouver, B. C.

teen thousand acres in the last decade of the 19th century to 112,000 acres in the last half of the last decade, i. e., from 1915 to 1921.

I.
Kentucky Drainage Projects.¹

| Date of organization of drainage enterprise | Land | | Assessed Area | |
|--|---------|----------------------|---------------|----------------------|
| | Acreage | Per cent of total | Acreage | Per cent of total |
| All operating enterprises . . . | 358,480 | 100.0 | 358,480 | 100.0 |
| 1890 to 1899 (1) | 15,111 | 4.2 | 15,111 | 4.2 |
| 1900 to 1904 | 28,085 | 7.8 | 28,085 | 7.8 |
| 1905 to 1909 | 69,741 | 19.5 | 69,741 | 19.5 |
| 1910 to 1914 | 131,160 | 36.6 | 131,160 | 36.6 |
| 1915 to 1919 | 112,583 | 31.4 | 112,583 | 31.4 |

(1) Includes 800 acres under individual ownership on which drainage was begun in 1888.

STATE DRAINAGE AREAS.

Those sections of Kentucky in which artificial drainage is destined eventually to bring about changed and improved conditions in health and agriculture do not occur as essentially contiguous regions. They may be divided, however, into three classes. These classes are as follows:

- (1) Overflow lands. These are the low bottom-lands of the State which are subject to seasonal overflow, where such overflow is not normally drained off from the land directly following the ebbing of the flood waters. Good examples of this type of land are found in close proximity to the Ohio River in the Ohio River bottoms from Catlettsburg to Hickman.
- (2) Valley filled lands. These lands are found principally in the western coal field where sediments washed in from the erosion of the hills instead of being removed by the streams have become impounded and have filled up the valley. An excellent example of this type of topography is found in Webster County in the vicinity of Clay.
- (3) Swamp lands. The swamp land areas of Kentucky are relatively small. These occur bordering the tributaries

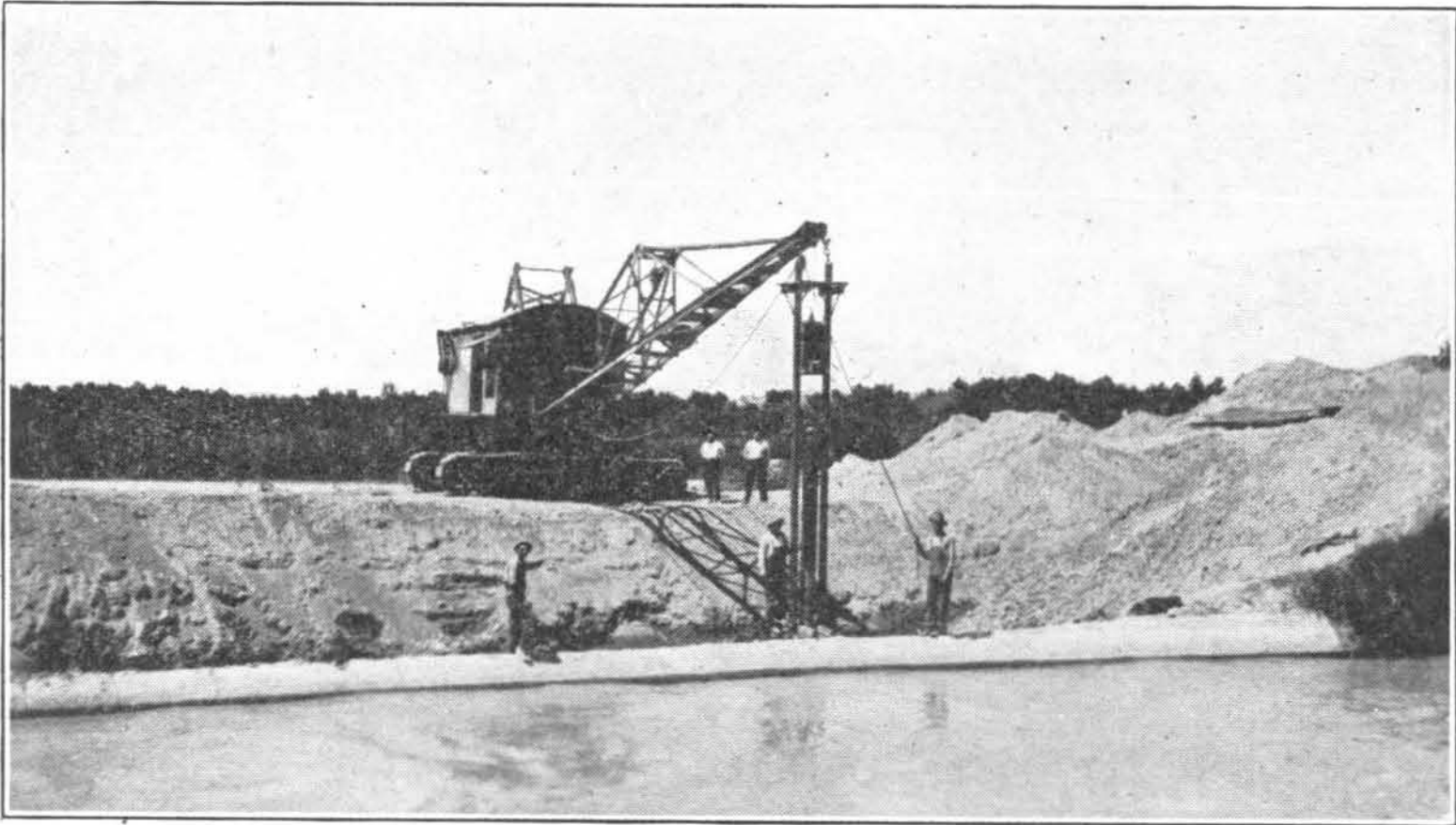
*U. S. Census, 1920.



MAP OF THE SOUTH PARK REGION.

The contrast of valley filled lowlands and rounded upland knobs is well depicted in this part of Jefferson and Bullitt Counties, Ky.

of some of the streams, emptying into the Ohio and Mississippi Rivers, especially in the "Purchase" region.



PILE DRIVER AT WORK.

This is the same machine No. 208 shown elsewhere rigged as a steam shovel excavator. Its adaptability to other occasional uses such as pile driving give it increased value to the operator.

In all these types of drainage areas the sediments involved are loose and readily susceptible to the employment of drainage projects.

DRAINAGE ENTERPRISE LEGISLATION.

The majority of the drainage enterprises in Kentucky are in reality drainage districts under the control of the county drainage commissioner. In Jefferson County where considerable work has been carried on, the enterprises are known as county drains, and are under the fiscal court. Nine of the enterprises operating in the State at present are under individual ownership, but the drainage law of 1912 provided that in each county where there is a public ditch, drain, levee, or similar improvements established, the county judge should appoint a board of three drainage commissioners. In 1918 an amendment to this law provides for the appointment of one county drainage commissioner. The drainage districts, with but a single exception, have been established by the county judges in accordance with the laws of July 10, 1893 (ch. 266), of March 23, 1900 (ch. 30), and of March 19, 1912 (ch. 132).



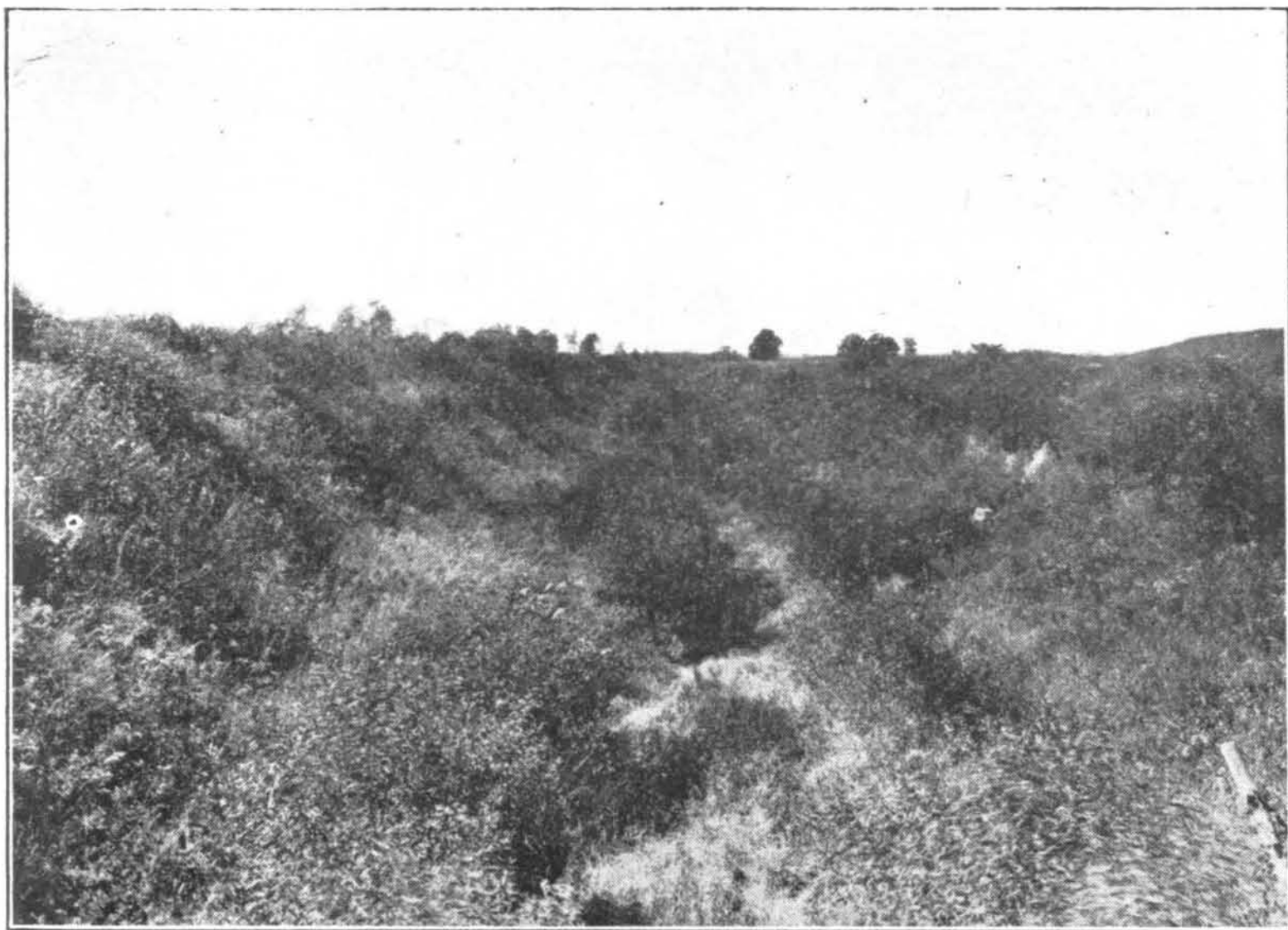
A "JACK AT ALL JOBS."

The excavating crane because of its long boom and extreme mobility under flooded conditions is adaptable to many uses. Here it is being used as a steam derrick hoist.

The law of 1893 was the first one to be passed in Kentucky with relation to drainage of the State. Under this law one or more persons interested might file a petition for a drain, and the count judge would subsequently appoint three viewers to examine the land that would be affected by the proposed work, locate the drain, assess benefits and damages, and determine whether the proposed improvement would be a public utility and benefit. The judge also ordered the establishment of the district finally, or dismissed proceedings, basing his judgment upon the report of the viewers. The law of 1912 required that only the original petition be signed by one or more owners of the land which would be assessed for the enterprise, but in 1918 (ch. 14), a law was made to require the signatures of at least 25% of the landowners, or the owners of not less than 25% of the land which might be affected. The drainage law of 1912 required that all ditches, levees, and other public improvements under control of the board of drainage commissioners, shall be kept in good repair by that board, which is authorized to appoint

a superintendent of drainage to have charge of the work. Assessments for maintenance and repair work may be made, apportioned like to cost of original construction, but not to exceed in any year 10 per cent of that cost.

The law of 1918 provides for maintenance of drainage work by the board of drainage commissioners. Both of these statutes define as public ditches all watercourses into which any public drains empty, and place such streams under control of the county drainage commissioners. The law of 1918 does not limit such natural public drains to non-navigable streams, as was done in the earlier statute. Further details concerning the drainage law of Kentucky may be found by consulting the statutes.



THE SOUTH DITCH.

The view is West from the Third Street Bridge. Willows and other small shrubbery have covered the bottom which will retard the flow and hasten the bottom filling.

EXTENT OF DRAINAGE.

The total amount of drainage completed by the various enterprises in Kentucky to and including the year 1919 comprise 664.5 miles of open ditches, and 86.2 miles of tile drains, and

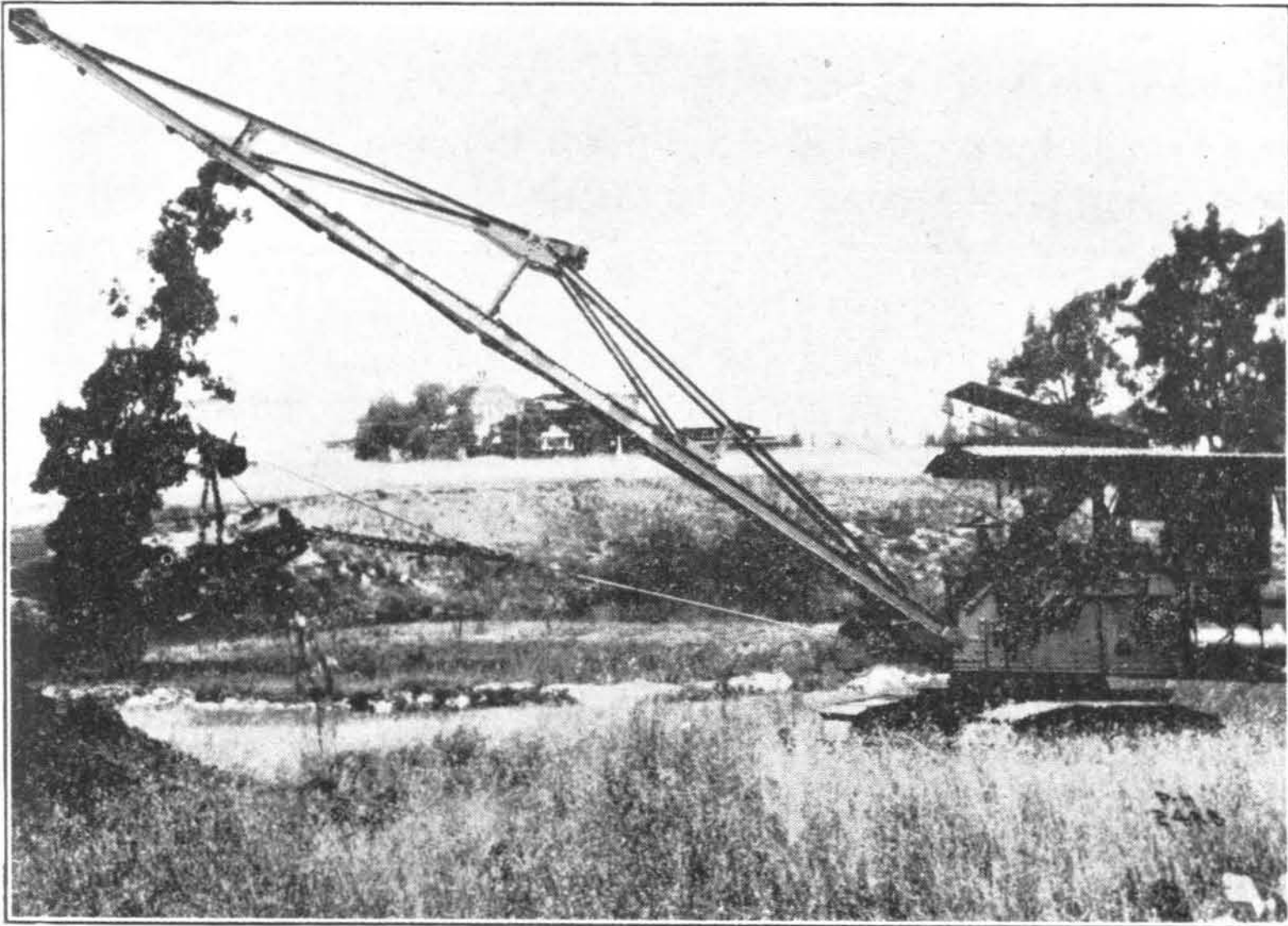
0.2 mile of accessory levees. The additional lengths under construction totaled 77.0 miles of open ditches and 1.0 mile of tile drains. These figures, however, do not include levees or drains installed for individual owners of farms, which may be regarded as additional to the main enterprises, nor do they include the works of flood protection of levee districts that had not undertaken the construction of ditches or tile drains. No pumping districts for land drainage are found in Kentucky: The extent and amount of capital invested in drainage enterprises in Kentucky is given in the following tables:

II.

*Land and Capital Invested in Operating Enterprises,—1920.**

| KIND OF WORKS | Land | | Capital | | Addi- tional required to com- plete. |
|---|---------|-------------------------|------------------|-------------------------|--|
| | Acreage | Per cent of total | To Dec. 31, 1919 | | |
| | | | Amount | Per cent of total | |
| All kinds | 358,480 | 100.0 | \$1,521,725 | 100.0 | \$299,271 |
| Open ditches only . . . | 345,605 | 96.4 | 1,406,696 | 92.4 | 295,701 |
| Open ditches and levees | 1,140 | 0.3 | 8,333 | 0.5 | |
| Tile drains only | 117 | (1) | 1,979 | 0.1 | |
| Open ditches and tile drains | 11,618 | 3.2 | 104,717 | 6.9 | 3,570 |
| (1) Less than one-tenth of 1 per cent. | | | | | |

*U. S. Census, 1920.



A SEWER DIGGER.

This sort of machine can be used satisfactorily by municipalities in sanitary work. It will successfully excavate a ditch four feet wide and 20 feet to 30 feet in depth.

III.

*Land in Operating Enterprises, Classified by Average Depth of Branch Ditches: 1920.**

| DEPTH OF BRANCH DITCHES | ACREAGE | Per cent of Total |
|---------------------------------|---------|----------------------|
| All operating enterprises | 358,480 | 100.0 |
| Less than 3 feet | 4,491 | 1.3 |
| 3.0 to 3.9 feet | 21,031 | 5.9 |
| 4.0 to 4.9 feet | 41,243 | 11.5 |
| 5.0 to 5.9 feet | 19,379 | 5.4 |
| 6.0 to 6.9 feet | 21,444 | 6.0 |
| 7.0 to 7.9 feet | 15,747 | 4.4 |
| 8.0 to 8.9 feet | 13,579 | 3.8 |
| Not reporting branches | 221,566 | 61.8 |

*U. S. Census, 1920.

KENTUCKY AND THE SOUTHEASTERN STATES.

Drainage work of a modern character in the southeastern States began with the enactment of the North Carolina Drainage Law in the year 1909. Up to that time none of the southern States had what would now be considered a workable drainage law. Hence little progress had been made. Among the difficulties which confronted the pioneer drainage engineers of the southeastern States were the following:

- (1) The validity of the laws had not been established.
- (2) Many laws were difficult to operate under.
- (3) Many engineering and construction problems had not been solved.
- (4) No market had been created for the bonds with which the districts were to be financed.
- (5) Landowners were frequently unfamiliar with the benefits of drainage.
- (6) Ignorance of the nature of the projects frequently resulted in widespread opposition of the drainage projects.

At the time drainage work started in 1909 there were approximately forty-six and one-half million acres of swamp, wet and over-flowed land that needed drainage. These lands were divided among the States as follows:

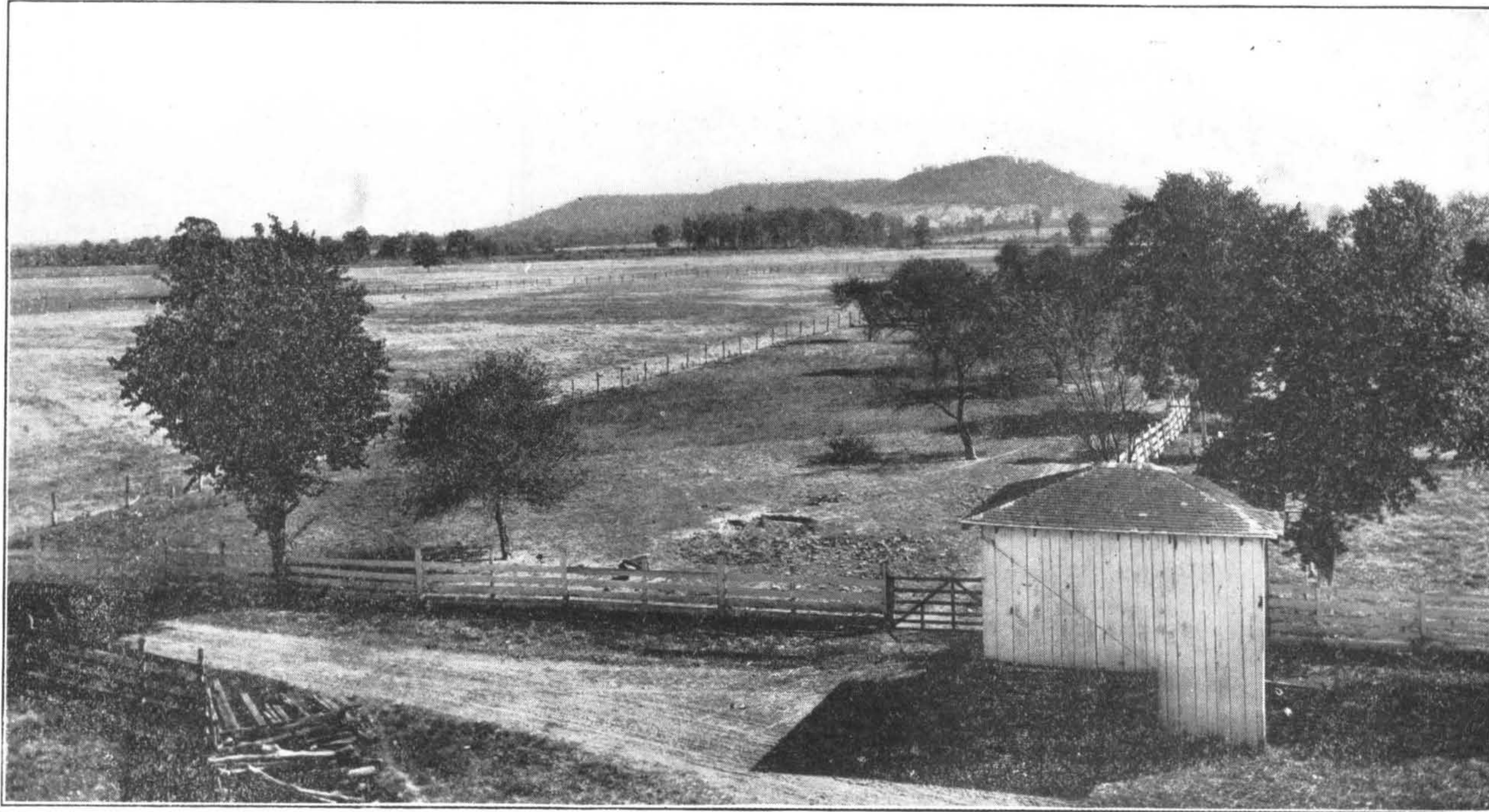
IV.

Area of Swamp, Wet and Overflow Land, 1909, Southeastern States

Area in Acres.

| State | Total | Permanent Swamp | Periodically Swampy | Periodically Overflowed |
|--------------------|------------|-----------------|---------------------|-------------------------|
| Alabama | 2,604,000 | 267,000 | 512,000 | 1,825,000 |
| Florida | 19,689,000 | 7,713,000 | 10,279,000 | 1,877,000 |
| Georgia | 7,896,000 | 2,271,000 | 2,582,000 | 3,043,000 |
| Kentucky | 1,715,000 | 15,000 | 200,000 | 1,500,000 |
| Mississippi | 6,008,000 | 560,000 | 2,570,000 | 2,878,000 |
| North Carolina ... | 5,653,000 | 2,220,000 | 2,488,000 | 945,000 |
| South Carolina .. | 4,440,000 | 2,023,000 | 1,906,000 | 511,000 |
| Tennessee | 1,270,000 | 40,000 | 16,000 | 1,214,000 |
| Virginia | 1,116,000 | 440,000 | 125,000 | 551,000 |
| | 50,571,000 | 15,549,000 | 20,678,000 | 14,344,000 |

The amount of drainage which had been completed by 1920 is indicated in the following table:



DRAINED LAND-CAPERTON RANCH.

This ranch of 1,300 acres straddles the South ditch between Louisville and South Park. It is practically all tillable land. Knob topography shows in the background.

V.

Areas Completely Drained. 1920, Southeastern States.

| State | Amount of Swamp, Wet and Overflowed Land 1909 Acres | Amount in Drainage District 1920 Acres | Cost of Drainage Improve- ments. (District) | Area still Unorganized Acres |
|-------------------|---|--|---|------------------------------------|
| Alabama | 2,604,000 | | | 2,604,000 |
| Florida | 19,869,000 | 1,367,000 | \$11,529,958 | 18,502,000 |
| Georgia | 7,896,000 | 104,000 | 828,683 | 7,792,000 |
| Kentucky | 1,715,000 | 475,000 | 1,650,925 | 1,240,000 |
| Mississippi | 6,008,000 | 1,910,000 | 7,239,607 | 4,098,000 |
| North Carolina .. | 5,653,000 | 543,000 | 3,623,518 | 5,110,000 |
| South Carolina .. | 4,440,000 | 155,000 | 618,083 | 4,285,000 |
| Tennessee | 1,270,000 | 443,000 | 3,041,515 | 827,000 |
| Virginia | 1,116,000 | | | 1,116,000 |
| Totals | 50,571,000 | 4,997,000 | \$28,532,289 | 45,574,000 |

At the present time about 10% of the wet, overflowed and swamp lands in the southeastern States has been included in drainage enterprises. It should be stated, however, that on much of this land work has never been started, while some main tracts have been provided with the major outlet drains only. Much of the work which has been done has been contracted along two major lines. A considerable portion of it at least will have to be deepened and extended at an additional expenditure of a considerable amount. In addition to 45,574,000 acres of overflowed land in the southeastern area, there is an area of land at least twice as great, that is badly in need of tile drainage. During the last decade there has been a steady increase in the amount of tile used in the southeastern States.

FLOOD CONTROL IN KENTUCKY.

The subject of flood control is one which invites serious consideration, and widespread interest, throughout the State of Kentucky. The engineering problems involved in this work have by no means been solved, and no means have yet been devised to protect the forests which are rapidly disappearing from the headwaters of the major streams of this State. Without some definite plan to be followed in the near future, the situation resulting from periodic floods is one which may be



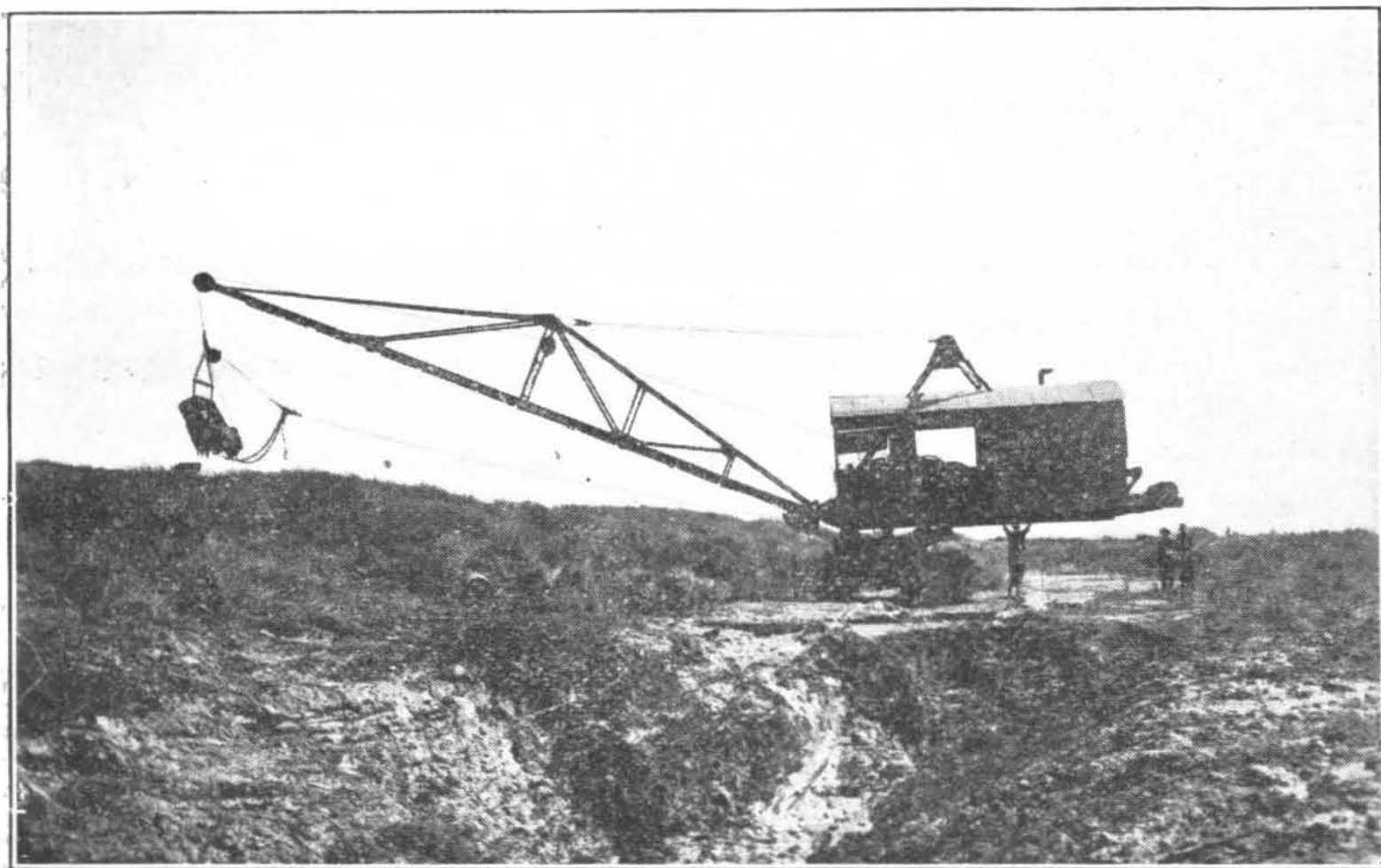
CLEANING OUT AN OLD DITCH.

The excavator-crane may be used to advantage in deepening silt-filled ditches and in clearing small vegetation from the sides.

expected to become gradually worse, rather than better, due to the extension of the area of cultivated lands and the removal of the forests cover. Both of which conditions allow a rapid run-off of the heavy seasonal rains. In Kentucky all of the major streams record a sudden rise after heavy rains, and then quickly return to the normal. They are what is called "flashy," having generally a high rate of discharge for a short period of time. To prevent erosion the ditches draining to them must be adequate to take the ordinarily sudden flow which comes after heavy rains or thaws. The intensity of the rainfall over short periods of time, therefore, becomes of great importance. Since the intensity of precipitation varies in different parts of the State, drainage projects will have to be adjusted accordingly.

The ideal in flood control would seem to be not only the enlarging of drainage ditches to take the occasional floods, but to so control run-off in the various areas as to deliver a fairly constant flow, or at least some flow which would not pass a certain predetermined amount. The prevention of floods differs con-

siderably from the control of floods, and the drainage engineer, due to the public neglect of the factors which would prevent floods, is concerned therefore primarily with the control of floods. The problem is to so regulate the discharge of flood water of any stream that it will rise only to a predetermined amount above its normal level. For this purpose it is necessary to study the character of the various drainage basins, and their normal drainage, and that of their tributary streams. It is necessary to know their rate of flow in flood, the time interval which the flood crest generally takes to reach the main stream, and the effect of the crestal floods discharged by the various tributaries on the flood crest of the main streams.



A MODERN DITCH-DIGGER.

This is a caterpillar self propelling steam shovel and boom. It is the No. 208 machine of the Pawling and Harmschfeger Co., now being used by the U. S. Reclamation Service in a number of its projects and could be used to advantage on many Kentucky drainage projects.

In reviewing the history of flood control it has been found that the most destructive floods occur when the crest flood of the main stream is met by the crest flood of the major tributaries. This will not last except for a very short time, but is frequently sufficient to be very disastrous to both life and property. By straightening and widening the channels of the main stream the delivery of flood waters may be hastened, and the

flood crest in the main stream is reduced in magnitude. Though this process generally insures some benefits, the total amount of water to be delivered by the stream is not greatly affected by it. When such measures as have been briefly suggested are ineffective or impossible to secure, the construction of retention flood reserve reservoirs becomes the necessary last resort. These reservoirs do not necessarily need to be large impounding basins with high dams. It is frequently possible on the tributaries of streams to erect a series of smaller dams and flood control basins which will operate to effectively retard the overflow of the water and prevent a simultaneous discharge of flood crests from the tributaries and main streams. This system of flood control engineering is well illustrated in the Miami Conservancy District near Dayton, Ohio, which is essentially a series of retarding flood basins at selected points on both the tributaries and the main streams.

PREVENTION OF EROSION.

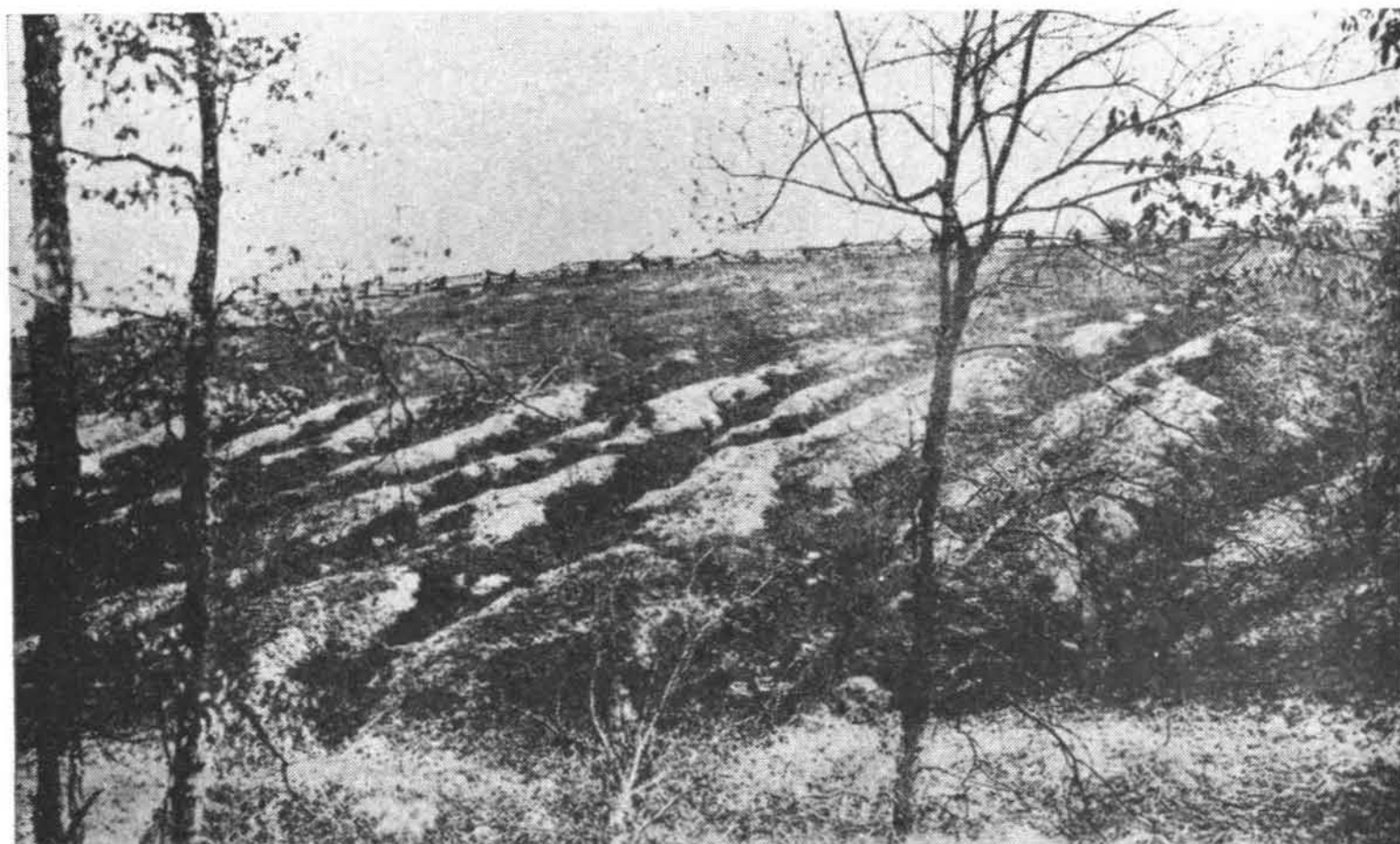
The prevention of erosion of the cultivated soils of Kentucky has been a subject of much oral and printed discussion.



GRAVELS NEAR SEDALIA.

Practically all of the gravel deposits of the Purchase Region are found to be badly washed wherever the forest or meadow cover has been removed. This exposure in Graves County is characteristic.

It is computed that an equivalent of \$1,300,000.00 annually goes down the streams of this State and is irretrievably lost in the rapid erosion of hillside farm lands and scouring out of fertile bottom-lands. Erosion is very active on the hill soils of Kentucky, especially in the Mountain and Knob regions where the soil is usually thin. In these regions the soils are generally of a shallow sandy loam, clayey-loam or a sandy-clay nature, underlaid generally at a depth of from a few inches to a foot or so by impervious sands or sandstones which do not afford a good absorbing agent for rapid precipitation. These soils are also low in humic acid because of their fine grained texture, and are very susceptible to rapid erosion or wash.



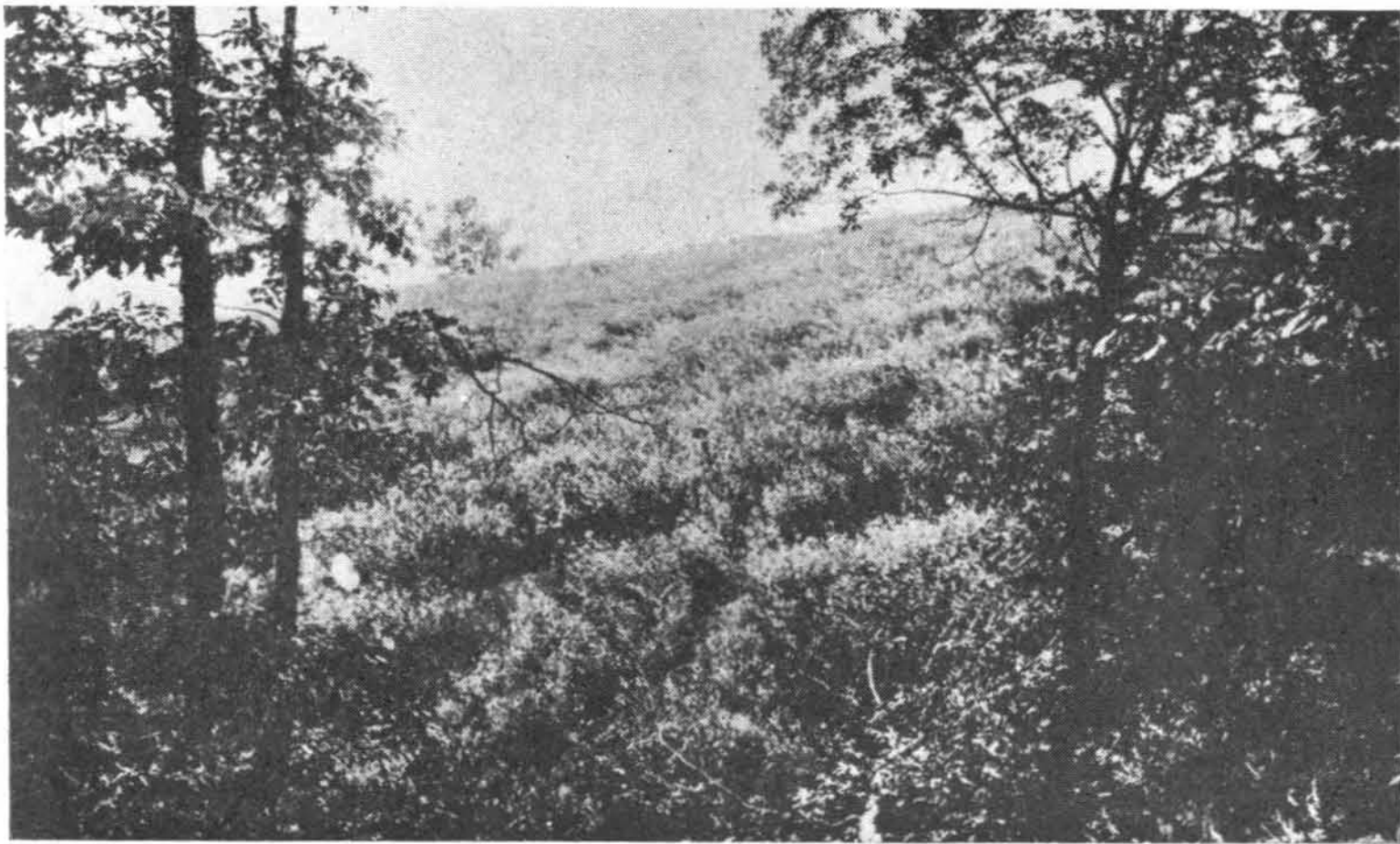
RAPID EROSION CHECKED.

This badly washed hillside is located in Pendleton County, Kentucky. Sweet clover has been planted in the gullies to check the rapid wash of the soil. See illustrated in the next photograph the results obtained.

It is estimated that the rivers of the United States carry over 100,000,000 tons of material each year, which has been robbed, for the most part, from the best and most productive farming areas. The James River of Virginia, with a 10-foot flood crest, has recently been figured to have carried 300,000 cubic yards of soil away during twenty-four hours, and the rivers of North Carolina carry away some 4,000,000 tons of soil, resulting in a yearly loss of over \$2,000,000 to that State. It is figured that

the rivers of Kentucky carry to the Mississippi River annually 5,000,000 tons of soil, which could it be retained within the State would add materially to the prosperity of this region.

Prevention of erosion is an engineering proposition, though one which is not very complicated for minor drainage units. While the farmer is competent to carry on much of this work, he should only do so following the advice of some competent engineer. Erosion is principally due to the uncontrolled movement of water over an unprotected surface, coupled with the inability of the soil to properly absorb this water. Anything which may be done to block this rapid movement and promote absorption of the water will lessen erosion and stop it before it begins, which is really the ideal. There are many ways of



WHAT SWEET CLOVER DID.

The practical results which may be obtained by using a good cover crop like deep rooted clover to check rapid wash is well illustrated here. This is the same field as shown in the photograph above, but later in the season. Rapid erosion has been stopped and this field saved.

promoting rain absorption by the soils. Among these may be stated the growing of cover crops, turning under vegetation and humus, and the practice of better methods of cultivation.

While all of these will help, they cannot in themselves entirely prevent erosion in climates of heavy precipitation. In the South generally, with the exception of Kentucky and Virginia, the use of terraces judiciously and correctly designed,

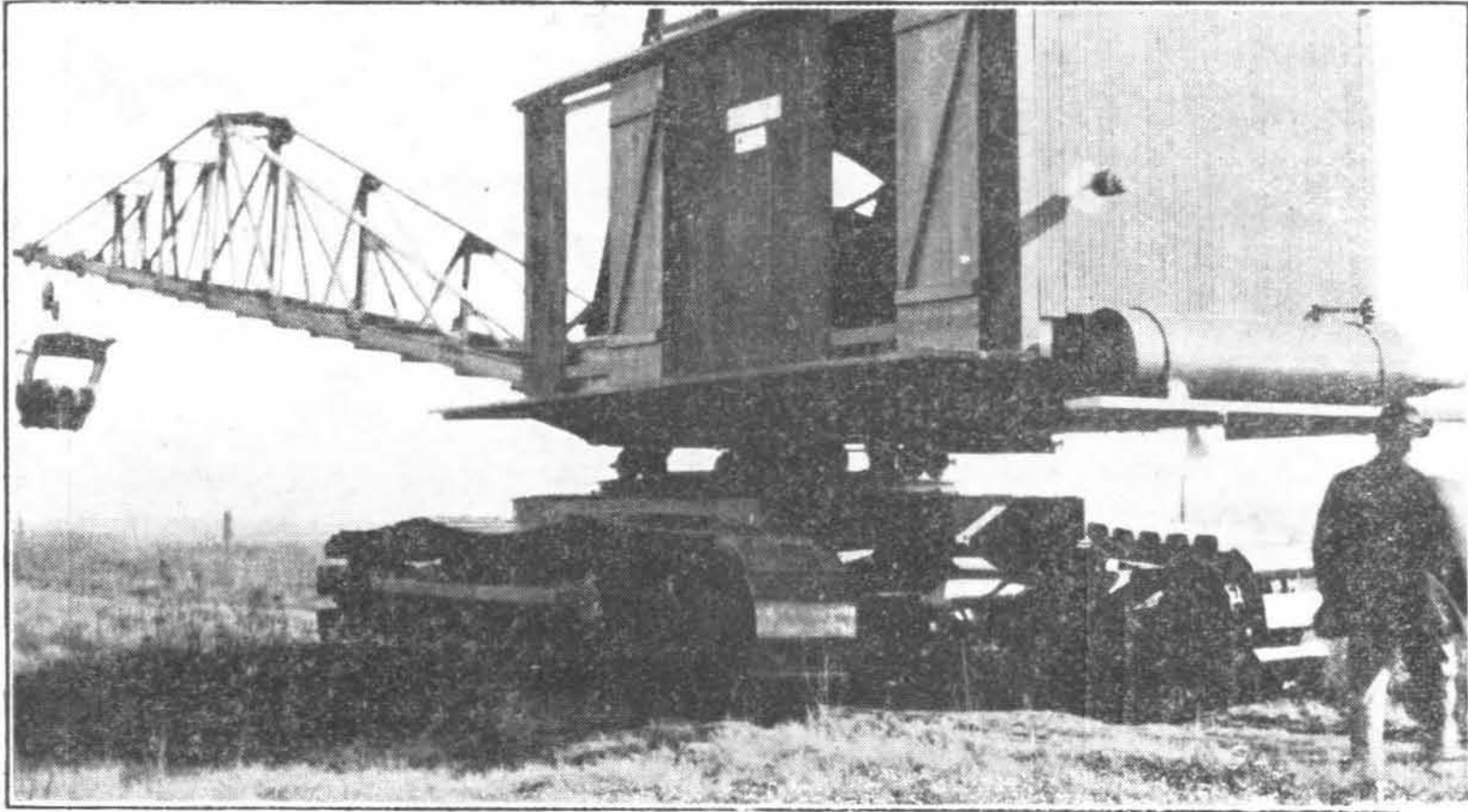
has been found to meet very satisfactorily local conditions. They are entirely practical and can be used upon washed lands on any farm, and are within the means of the small farm operator. With the introduction of terraces in some Kentucky localities, coupled with the suggested methods of cultivation and cropping, the extensive and bankrupting washing and erosion now found in many parts of this State might be practically eliminated.

VALUE OF RECLAIMED LANDS.

It is quite impossible to draw generally applicable conclusions for the value of drainage improvement, because of the extreme range of cost and the varying value of results obtained. The improvement of one section may cost from \$10.00 to \$20.00 per acre, another may cost much more. This drainage improvement might increase the value of land from an original value of from \$10.00 to \$15.00 per acre to \$100.00 or \$200.00 per acre. This has frequently been the case in the drainage projects of North Carolina and Virginia. Recently, North Carolina* has announced that a half million acres in its Coastal Plains Region has been increased in value by drainage from 25 to 50 cents an acre to from \$50.00 to \$200.00 per acre. In the State of Minnesota, through the completion of some rather large and recent enterprises there, the land was raised from \$1.00 an acre to \$300.00. In the State of Kentucky the completion of drainage projects in Jefferson County and in Clay County, which are representative of the areas principally in need of work in this State, has resulted in the increased valuation of the land from \$5.00 to \$100.00 and \$150.00 per acre.

Other individual cases in Kentucky could be cited where the improvement has resulted in a much greater increase of value to the agricultural districts. It is a fact that there are still large areas of poorly drained and overflow bottom lands in the western and southwestern part of this State which if properly drained could be reclaimed from a valuation of not more than \$2.00 to \$5.00 per acre to a valuation of \$50.00 or \$100.00. At the present time there are within the State of Kentucky 270,626

*North Carolina adds \$60,000,000 by Reclamation, J. H. Pratt, Natl. Reclamation Magazine, Vol. 1, No. 1, p. 6, Dec., 1921.



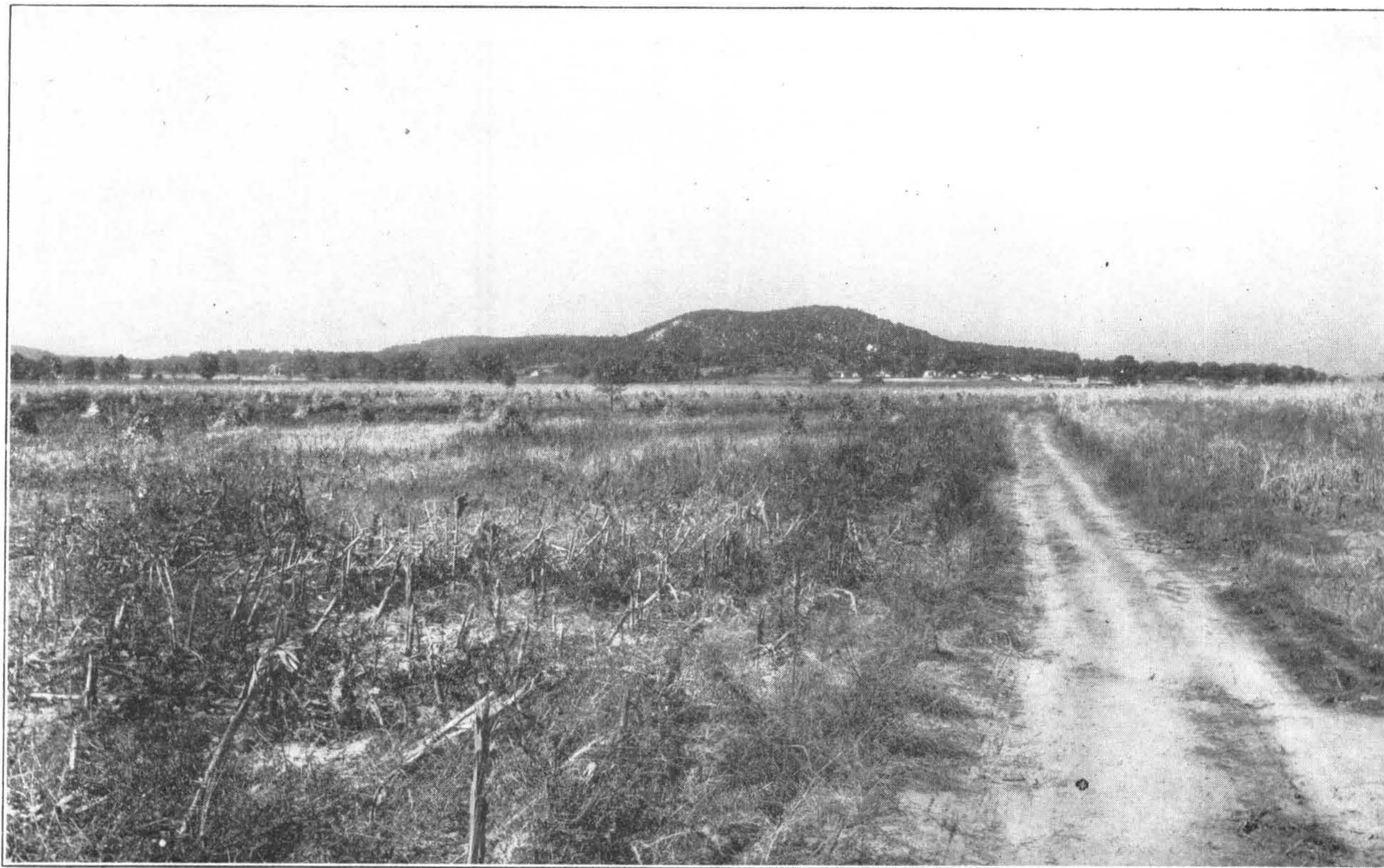
AN EXCAVATING CRANE IN DETAIL.

The compact yet sturdy construction of these "ditch diggers" is well illustrated. The caterpillar tread gives them extreme mobility even in submerged or boggy places, thereby allowing the work to proceed even during flood periods.

farms. Of these, 5,817 report the drainage enterprises already established, and 19,592 farms report the pressing need of new drainage enterprises. There are 773 farms principally within the levee districts of the Mississippi and Ohio Rivers which could be improved by drainage projects.

SUMMARY.

While the benefits accruing from drainage enterprises in Kentucky, as in every other state, are largely materialistic, and while it is certain that no drainage enterprise here would ever be undertaken if the project did not offer the prospect of a large capital return, it may be said that in the race for wealth the real fundamental thought behind all drainage projects—that of providing new and better homes for self-supporting citizens—should not be forgotten. The duties of our day in reclamation work really go far beyond the making of money. Any district in Kentucky which is to be successfully improved by drainage, or reclaimed from swamp, must not only be a profitable investment, but must provide a larger habitable and more prosperous agricultural region capable of a greatly increased production and capital assessment.



RECLAIMED LAND IN JEFFERSON COUNTY.

These bottoms are drained by the North Ditch. The area is about three miles south of Louisville. Typical Knob topography is seen in the background.

Engineers and drainage commissioners should not regard the completion of their contract as an end of the work. The right kind of people, those who are suited to the land, should be drawn into the district. The newly reclaimed or improved areas should not be left to inexperienced managers, who frequently through ill advised methods require the settlement of the land two or three times over. This sort of thing is unnecessary, and too costly. A good settler is one who has a small capital, considerable experience in farming reclaimed or improved lands, and possessed of a family. He should not have too much land, as it will be apt to break him. A few thousand dollars of capital is absolutely necessary.



A KENTUCKY HILLSIDE OF NO VALUE.

When the Jefferson County farmer cut away his brush cover on this hill he threw his land away. Thousands of tons of soil have been removed here by erosion.

State laws should be devised to eradicate the swindling of unsuspecting investors. Land frauds must and will eventually be stopped. Closely following the opening up of each newly reclaimed or improved area, should come the establishment of a number of well selected families, with competent and sufficient



AN INEXCUSABLE BUT COMMON CONDITION.

The removal of the timber cover from steep hillsides invites this farming disaster which is a growing menace in many parts of Kentucky. The geologic formation here is The New Providence (Mississippian) and the location is South of Louisville in Jefferson County.

hired help. The hired man soon becomes a renter on this tract, and follows from this position to that of landowner in natural sequence. The financing of Kentucky's new drainage projects is one of the most important problems to be solved in the present decade. The large amount of drainage which is now needed in this State will not be undertaken and satisfactorily completed until such bond issues as are necessary for these projects are made as safe or safer than the best municipal bonds the market affords.

